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of opinion, it still seems to me to be advisable to keep an open mind on the possibility that the syenite and anorthosite occur "*substantially* as layers with the syenite above." It is especially desirable in view of the fact, recognized by Professor Cushing, that the anorthosite occurs in the more deeply eroded portions and the syenite principally at higher horizons, an arrangement not easily reconciled with the opinion that the syenite pushes up into the anorthosite from below.

ADIRONDACK INTRUSIVES

H. P. CUSHING

I am greatly indebted to Dr. Bowen for his additional contribution to this discussion. I take the liberty of considering briefly the points he brings out.

He suggests that the chilled gabbro border of the anorthosite is not a lateral border but a remnant of an upper one. It is very difficult for me clearly to visualize the structure of the region on this view. It is, roughly, about 100 miles across the mid-Adirondack region from east to west, and, again roughly, the easterly half of this distance is occupied by pretty clean anorthosite, and the westerly half contains a great number of syenite bodies and no anorthosite at all. The chilled gabbro border is about midway of the region. If it is a chilled upper portion of a laccolith, consisting of pyroxenite and gabbro below, then anorthosite, then syenite, and, finally, the chilled gabbro roof, since tilted so that the present erosion surface cuts it at a considerable angle, it is necessary to conceive that this chilled upper surface passes below ground in the westerly direction and into the air to the east. Under such a view the present-day syenite masses of the west must have broken through this cover to reach their present position, and there is no particular difficulty in imagining that they did so. But under this view it seems to me necessary that we should also find syenite to the east of the chilled border and close to it—that syenite which formed as a differentiate in the upper part of the chamber, underneath the chilled upper surface. Even if the upper part was very irregular, as Bowen suggests, so that the syenite differentiate was in separate masses instead of in a continuous sheet, there should still remain considerable masses of syenite within the chilled border and underlying it, if this border was an upper instead of a lateral one. We should find gabbro passing into syenite and this into anorthosite. I know of no such syenite masses within the gabbro border anywhere in the region; and to explain their absence we should be, it seems to me, forced to the conclusion that, owing to disturbance during a late stage of consolidation, every particle of this syenite differentiate in the upper part of the body was forced out through the roof to higher levels, letting the chilled gabbro down upon the anorthosite. This is perhaps possible, but certainly very unlikely, and, moreover, it would leave unexplained the usual slow and even gradation from border gabbro into anorthosite gabbro and of this into anorthosite as we recede from the border—a feature which seems to me convincingly to suggest a lateral border rather than an upper one.

In the Palisade sheet, utilized as an illustration by Bowen, the acidic types lie directly underneath the upper chilled border. In the Adirondacks they lie without and above rather than within and below this border, as they should do on the sheet conception. None of the outlying masses of syenite known to me show any sign of a chilled border of gabbro as if they were upper parts of a single large body. They all seem rather of the type of injections upward from some large mass of magma below. It is to be understood that I am not objecting to the laccolithic conception, but to the conception of a single laccolith occupying the entire region. If we regard the anorthosite mass as a single mass, its margins shown by the chilled border, attacked shortly after its formation by masses of syenite magma, which arose from one or more separate and deeper bodies to the west and which came up along the margin of the anorthosite, not through it, we obtain an explanation of the abrupt transition from anorthosite to syenite territory which obtains in the region and we are free from the difficulties which have just been discussed.

Dr. Bowen's contention that the present-day ideas in regard to the time relationship between syenite and anorthosite are chiefly due to my observations on the Long Lake quadrangle is correct, but needs some comment in order not to be misleading. The anorthosite district is rugged, wooded, and difficult. Very little of it has been mapped in detail on quadrangle maps. Moreover, the marginal types are weaker and less likely to be well exposed. It is as yet unsafe to argue that the Long Lake phenomena are exceptional because they have not been shown elsewhere.

I regret that Dr. Bowen did not discuss my suggested explanation of the Placid syenite inlier as a remnant of the overlying syenite differentiate of the anorthosite. It is there that he found his rocks transitional between syenite and anorthosite, and it is there that they would be expected, if the inlier is such a remnant. These rocks are not on the border, but are within the mass. If a chilled border is lacking between them and the adjacent anorthosite, then the occurrence would seem most easily explained on this theory.

In conclusion, then, the relations shown in the field along the western border of the anorthosite seem to me to indicate that the anorthosite is one body and the syenite masses to the west and south belong to one or more separate and slightly later bodies. While I welcome Dr. Bowen's theory of the formation of the anorthosite and syenite, I can neither agree with, nor see the necessity of, his idea that all these intrusives of the region are parts of one single laccolithic body. As I picture it, they must represent separate upwellings from one or more deeper-seated magmas. The western border of the anorthosite marks the line of division of the region into contrasted halves—anorthosite to the east, separate syenite masses to the west; and the particular syenite masses which happened to adjoin the anorthosite differ in no particular from those more remote, except in the one that they have assimilated some anorthosite at the contact of the two rocks. Nothing is to be gained by assuming that the adjoining masses belong with the anorthosite body and by attempting to make a separation between them and those more remote. Such a separation would be purely arbitrary, whereas the other divisional line is sharp and obvious.